

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property  
Organization  
International Bureau



(43) International Publication Date  
1 July 2004 (01.07.2004)

PCT

(10) International Publication Number  
**WO 2004/054744 A1**

(51) International Patent Classification<sup>7</sup>: **B22F 7/00**

(21) International Application Number:  
PCT/EP2003/014060

(22) International Filing Date: 5 December 2003 (05.12.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
MI2002A002676  
18 December 2002 (18.12.2002) IT

(71) Applicant (for all designated States except US): **NUOVO  
PIGNONE HOLDING S.P.A.** [IT/IT]; Via F. Matteucci 2,  
I-50127 Firenze (IT).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **COPPOLA,**

**Alessandro** [IT/IT]; Via Righi, 60, I-59100 Prato (IT).  
**INNOCENTI, Marco** [IT/IT]; Via Crocetta e Sammommé  
1/a, I-51100 Pistoia (IT).

(74) Agents: **COPPO, Alessandro** et al.; Ing. Barzanò & Za-  
nardo Milano S.p.A., Via Borgonuovo, 10, I-20121 Milan  
(IT).

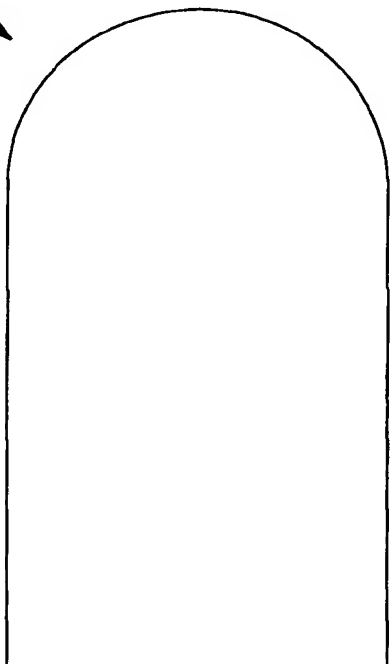
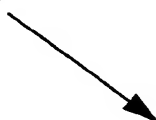
(81) Designated States (*national*): AE, AG, AL, AM, AT, AU,  
AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR,  
CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD,  
GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR,  
KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN,  
MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU,  
SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA,  
UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States (*regional*): ARIPO patent (BW, GH,  
GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW),  
Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),

[Continued on next page]

(54) Title: MANUFACTURING METHOD FOR OBTAINING HIGH-PERFORMANCE COMPONENTS FOR GAS TURBINES  
AND COMPONENTS THUS OBTAINED

110



(57) Abstract: A manufacturing method for obtaining im-  
proved components (110) for gas turbines, which includes  
at least one process involving powder sintering or powder  
metallurgy with homogeneous/heterogeneous dispersion of  
powders; the invention also relates to the improved compo-  
nents obtained with this method.

WO 2004/054744 A1



European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

**Published:**

— *with international search report*

JC20 Rec'd PCT/PTO 17 JUN 2005

MANUFACTURING METHOD FOR OBTAINING HIGH-PERFORMANCE  
COMPONENTS FOR GAS TURBINES AND COMPONENTS THUS  
OBTAINED

5 The present invention relates to a manufacturing method  
for obtaining improved components for gas turbines.  
The invention also relates to these improved components  
thus obtained.

As is known, gas turbines are machines consisting of a  
10 compressor and a single or multiple-stage turbine,  
where these components are connected together by a  
rotating shaft and where a combustion chamber is  
provided between the compressor and the turbine.

Air from the external environment is supplied to the  
15 compressor in order to pressurise it.

The pressurised air passes through a series of pre-  
mixing chambers which terminate in a converging portion  
and in each of which an injector feeds fuel which is  
mixed with the air so as to form an air/fuel mixture to  
20 be combusted.

The fuel is introduced into the combustion chamber and  
is ignited by means of suitable igniter plugs so as to  
produce combustion, which is aimed at causing an

increase in temperature and pressure and therefore enthalpy of the gas.

At the same time, the compressor provides pressurised air which is made to pass both through the burners and  
5 through the linings of the combustion chamber so that the abovementioned pressurised air is available for fuelling combustion.

Subsequently, the high-temperature and high-pressure gas reaches, by means of suitable ducts, the different  
10 stages of the turbine, which converts the enthalpy of the gas into mechanical energy available for a user.

It is also known that, in order to obtain the maximum efficiency from a given gas turbine, the temperature of the gas must be as high as possible; however, the  
15 maximum temperature values which can be reached during use of the turbine are limited by the strength of the materials used.

In fact, the increase in the compression ratio and the combustion temperature have a synergic effect on the  
20 performance characteristics of the gas turbine cycle, be it of the single or combined type: manufacturers are aware that their competitiveness within the market depends on the ability to make progress in this connection.

These two parameters must be clearly defined in relation to the technology and materials which, for the sake of economic advantage, are to be used during design of the machine.

5 According to the present state of the art, it is envisaged, for example, that the stator blades of the first expansion stages of a gas turbine are made by means of microfusion of typically nickel or cobalt-based superalloys, always in conjunction with cooling  
10 measures.

The following stages are also made by means of microfusion of superalloys, all cobalt or nickel-based materials with an excellent oxidation resistance and reasonable mechanical properties, at least up to  
15 temperatures of about 800°C; in the case of higher temperatures suitable cooling is therefore required.

In view of the temperatures involved, the oxidation resistance and corrosion strength of these superalloys in the hot state would clearly be inadequate if cooling  
20 and screening of the surfaces with a film of cooling air were not envisaged.

The cooling techniques, no matter how sophisticated, would nevertheless no longer be able to ensure an adequate duration of the components if technologies for

protecting the metal surfaces with the application of heat and anti-oxidant barriers had not been introduced. At present, the increase in the current performance characteristics is now sought after, rather than by  
5 using increasingly sophisticated basic materials for the blades, by means of the development of heat and anti-corrosion barriers and generally coatings which offer an increasingly optimum performance compared to the present platinum, chromium and aluminium linings.

10 However, the development of heat barriers is also reaching its limits in terms of manufacturing and application technologies.

Basically it is noted that, during the use in industrial gas turbines with high combustion  
15 temperatures, the components of the gas turbine made of homogeneous metallic and non-metallic materials have a low resistance to the high-temperature thermomechanical stresses.

It is therefore necessary to adopt compromises during  
20 the design and choice of materials in order to achieve performance characteristics which are acceptable in terms of duration, reliability, industrial feasibility and performance of the machine in which these components are incorporated.

The consequence of this is also the difficulty of developing cooling flows which are suitable for limiting the oxidation of the metal components used.

In practice, the increasingly greater efficiency levels  
5 required result in an increase in the cycle temperatures which render the conventional constructional solutions unsuitable from the point of view of increasing and/or maintaining the working life of the components which are subject to high  
10 temperatures, or so-called hot components.

The object of the present invention is therefore that of overcoming the drawbacks mentioned above and in particular that of indicating a manufacturing method for obtaining high-performance components for gas  
15 turbines which manage to withstand increasingly higher temperatures.

Another object of the present invention is that of providing improved components for gas turbines which allow the attainment of very high compression ratios  
20 which cannot be achieved conveniently with the components known in the art.

Another object of the present invention is that of indicating a manufacturing method for obtaining

improved components for gas turbines which are particularly reliable, with a relatively limited cost.

These and other objects according to the present invention are achieved by indicating a manufacturing

5 method for obtaining improved components for gas turbines, as described in Claim 1. Claim 6 specifies how these improved components for gas turbines are obtained. Further characteristic features of the invention are envisaged in the remaining claims.

10 The characteristic features and advantages of a manufacturing method for obtaining improved components for gas turbines and the components thus obtained in accordance with the present invention will become clearer and more obvious from the following description

15 provided by way of a non-limiting example, with reference to the accompanying schematic drawings in which:

Figure 1 is a diagram of an improved component part for gas turbines, obtained in accordance with the

20 manufacturing method of the present invention;

Figure 2 is a diagram of the same component part as in Figure 1, obtained in accordance with the prior art.

With initial reference to Figure 2, this shows a part of a component for gas turbines, which is denoted



overall by 10 and obtained in accordance with the prior art.

The component 10 comprises an internal metal body 12 obtained by means of microfusion or mechanical  
5 machining. An external protective body 14 made of generally homogeneous ceramic material is added on top of it. An interface and bonding zone 16 is provided between the internal body 12 and the external body 14.

In the example illustrated in Figure 1, according to  
10 the present invention, part of an improved component 110 for gas turbines, obtained in accordance with the manufacturing method of the present invention, is shown.

The improved component 110 is made by means of at least  
15 one process involving metallic and non-metallic powder sintering or powder metallurgy with homogeneous/heterogeneous dispersion of the powders.

The dispersion or diffusion of the said powders is performed in a predefined manner so as to expose  
20 surfaces with suitable concentrations of high-refractory non-metallic powders to very high temperature gaseous flows.

Moreover, the diffusion of the powders performed in this predefined manner allows perfect fixing to the

metal surfaces in a zone forming an interface with internal bodies produced by means of microfusion.

The composition of the sintered product, owing to suitable balancing and diffusion of the powders during  
5 production and distribution of the concentrated component powders within the geometry of the sintered product, results in different chemical/physical properties in different points with a relative variability determined by the functional specification  
10 defined during the design stage.

As a result of this manufacturing technique it is therefore possible to obtain an optimum tensile and thermal stress distribution, with an optimum strength of the sintered component, thereby maximising the  
15 working life of the component.

It is clear from that stated that the present invention represents a technological leap from components made of isotropic and homogeneous materials, if necessary with coatings of various kinds, to sintered powder  
20 components which have different properties in different points with continuous variation thereof. This is due to a composition which is no longer uniform, but continuously variable and suitably calibrated according

to the requirements of the various zones of the component.

Suitable distribution of the powders, for example, result in components having a maximum refractoriness in  
5 respect of hot gases, along with an improved behaviour at the bonding interface with a microfusion zone of the component: in this way the sintered product is not simply a coating of the component, but forms an integral part thereof.

10 The main result of the present invention is the possibility of achieving a robust design with the manufacture of inserts made of material resistant to high temperatures, obtained by means of sintering of mixtures of metallic and non-metallic powders with  
15 heterogeneous/ homogeneous dispersion.

The above description clearly demonstrates the characteristic features of the manufacturing method for obtaining improved high-performance components for gas turbines and the components thus obtained, according to  
20 the present invention, as well as the advantages arising therefrom.

The following final considerations and comments are added here in order to define more precisely and clearly the abovementioned advantages.

Firstly it is pointed that, with the manufacturing method for obtaining improved high-performance components for gas turbines according to the invention, it is possible to obtain components which are resistant  
5 to very high temperatures.

In this way very high compression ratios of the gas turbine are achieved, of the kind which cannot be obtained economically with the components known in the art, while ensuring the availability of very reliable  
10 parts at a relatively low cost.

Finally it is clear that the manufacturing method for obtaining improved high-performance components for gas turbines as well as the resultant components, thus conceived, may be subject to modifications and  
15 variations all within the scope of the invention; moreover all the details may be replaced by technically equivalent elements. In practice the materials used, as well as the forms and dimensions, may be of any nature in accordance with the technical requirements.  
20 The scope of protection of the invention is therefore delimited by the accompanying claims.

## CLAIMS

1. Manufacturing method for obtaining improved  
high-performance components (110) for gas  
5 turbines, characterized in that it includes at  
least one process involving powder sintering or  
powder metallurgy with homogeneous/heterogeneous  
dispersion of said powders.
2. Manufacturing method according to Claim 1,  
10 characterized in that said powders are metallic  
and non-metallic.
3. Manufacturing method according to Claim 1,  
characterized in that said dispersion of said  
powders is performed in a predefined manner  
15 resulting in suitable concentrations of said  
powders in suitably designated zones.
4. Manufacturing method according to Claim 1,  
characterized in that said dispersion of said  
powders is performed in a predefined manner  
20 resulting in perfect fixing to metal surfaces in a  
zone (16) forming an interface and bond with  
internal bodies (12) produced by means of  
microfusion or mechanical machining.

5. Manufacturing method according to Claim 1, characterized in that said dispersion of said powders is performed with suitable balancing and dispersion of said powders which produces different chemical/physical properties in different points of said components.
6. Improved high-performance components (110) for gas turbines, characterized in that they are obtained by means of at least one process involving powder sintering or powder metallurgy with homogeneous/heterogeneous dispersion of said powders.
7. Improved high-performance components (110) according to Claim 6, characterized in that distribution of said powders results in maximum refractoriness and resistance in respect of hot gases.
8. Improved high-performance components (110) according to Claim 6, characterized in that distribution of said powders results in perfect fixing to metal surfaces in a zone (16) forming an interface and bond with internal bodies (12) produced by means of microfusion or mechanical machining.

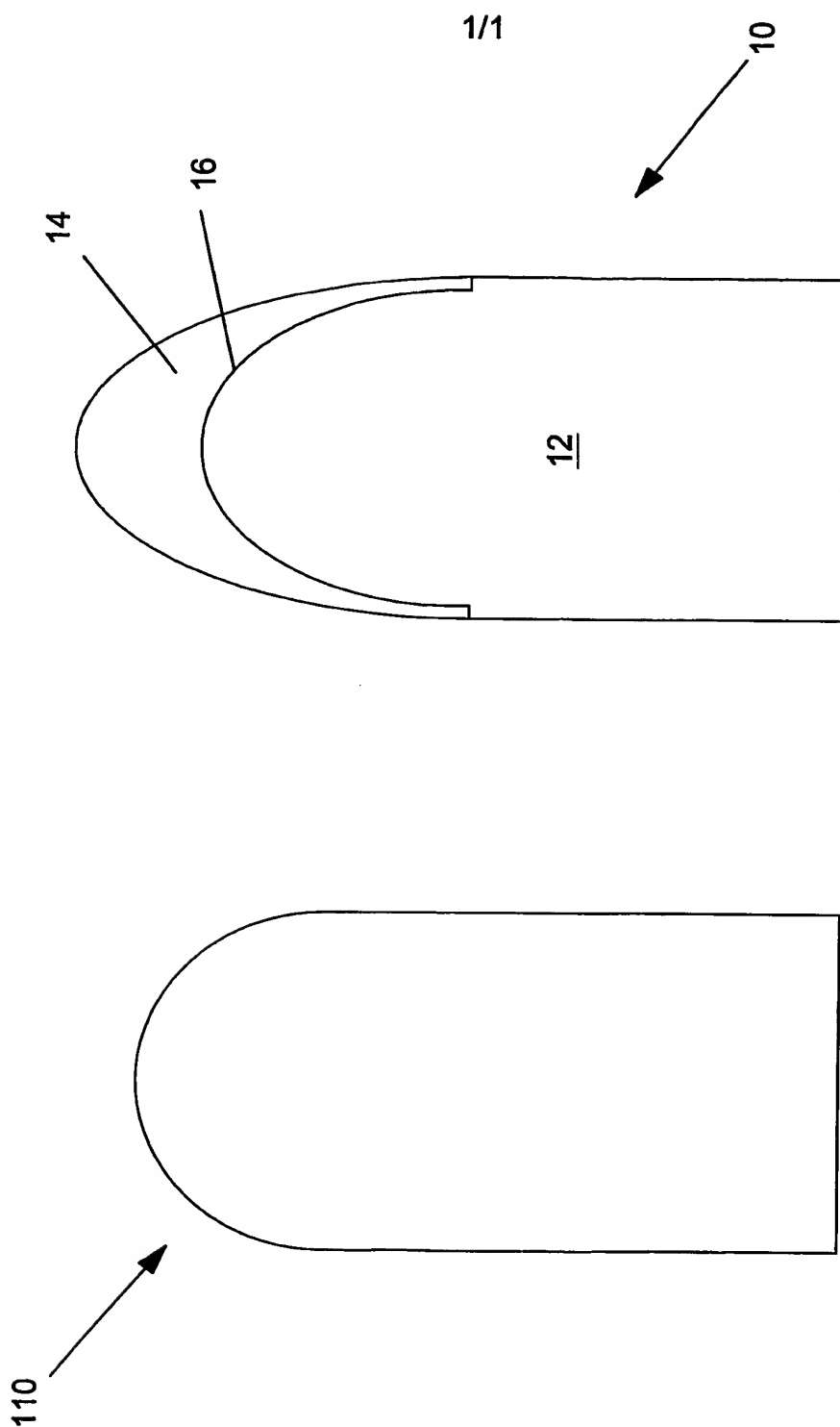


Fig. 2  
PRIOR ART

Fig. 1

# INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 03/14060

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 7 B22F7/00

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B22F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 322 897 B1 (WILLERT-PORADA MONIKA ET AL) 27 November 2001 (2001-11-27) abstract claim 18	1-8
X	US 3 802 850 A (CLOUGHERTY E) 9 April 1974 (1974-04-09) abstract column 1, line 5 - line 27	1-8
X	US 4 101 712 A (BOMFORD MICHAEL J ET AL) 18 July 1978 (1978-07-18) claims	1-8

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

\* Special categories of cited documents :

- \*A\* document defining the general state of the art which is not considered to be of particular relevance
- \*E\* earlier document but published on or after the international filing date
- \*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- \*O\* document referring to an oral disclosure, use, exhibition or other means
- \*P\* document published prior to the international filing date but later than the priority date claimed

- \*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- \*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- \*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- \*G\* document member of the same patent family

Date of the actual completion of the international search

16 February 2004

Date of mailing of the international search report

24/02/2004

Name and mailing address of the ISA  
European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Alvazzi Delfrate, M



# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/EP 03/14060

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 6322897	B1	27-11-2001	WO 9853940 A1	03-12-1998
			DE 59803436 D1	25-04-2002
			EP 0984839 A1	15-03-2000
			JP 2002502462 T	22-01-2002
US 3802850	A	09-04-1974	NONE	
US 4101712	A	18-07-1978	CH 602237 A5	31-07-1978
			DE 2503165 A1	24-06-1976
			FR 2295809 A1	23-07-1976
			GB 1525290 A	20-09-1978
			JP 1220267 C	26-07-1984
			JP 51087108 A	30-07-1976
			JP 58052524 B	24-11-1983